NYS·TEC

NEW YORK STATE TECHNOLOGY ENTERPRISE CORPORATION

presents its Draft Final Report for

Building a Bridge to the Corn Ethanol Industry

Subcontract No. ZXE-9-18080-05

Submitted to:

National Renewable Energy Laboratory (NREL)
1617 Cole Boulevard
Golden, CO 80401-3393

December 31, 1999
Revision 0

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Executive Summary

Historically, most ethanol produced in the United States is produced from corn. NREL has done extensive work over the past few years to develop the Lignocellulosic Biomass to Ethanol Process. Utilizing this technical process, many agricultural products or food-processing-waste products can be used to produce ethanol

Although ethanol is not currently being produced in New York State, the diversity of the agricultural and forestry industries here presents a wide range of potential feedstocks for ethanol production. Under this study, the New York State Technology Enterprise Corporation (NYSTEC) Alternative Fuel Technology Center (AFTC) has evaluated NREL's Lignocellulosic to Biomass technology against the New York State feedstock supply. Along with our subcontractors, Raytheon Engineering and Constructors, we have assessed the technical and economic feasibility of using this technology to produce fuel ethanol in New York State. The results of our study are contained in this report.

Our study targeted at an existing grain processor, Robbins Corn and Bulk Service. NYSTEC's study concludes that although the Robbins facility is not an appropriate site for ethanol production, New York State grows enough corn stover, hay and straw to produce 240 million gallons of ethanol annually using the lignocellulosic technology. The overall economics, however, have not been found to be promising at this time. Plant construction costs of $230 million have been estimated under this study. Due to those significant capital costs, our financial pro formas and the results of our sensitivity analysis indicate that the plant would not be profitable until its 20th year. As a result, the sale price of ethanol for fuel use could not compete with existing mid-west prices.

Results of this report conclude that New York State ethanol production is feasible and that ways to make it affordable should be pursued further. NYSTEC remains confident that, in the long run, the Lignocellulosic Biomass to Ethanol process will be "the way to go" in fuel ethanol production. This is due to the fact that production will not directly compete with the food supply and that feedstocks will tend to be cheaper to produce and obtain. NYSTEC is also encouraged that the results of this and other NYSTEC studies indicates that the production and use of ethanol as a cleaner, renewable replacement for fossil fuels has significant economic and environmental potential in New York State.

At the end of this report, NYSTEC has outlined ideas for projects that will help to address the affordability issue identified in our analysis. We look forward to discussing these ideas with NREL to determine mutual interest and potential benefits.

1. Feedstock Analysis

1.1 Introduction

Many agricultural products or food-processing-waste products can be used to produce ethanol. With its diverse agricultural and forestry industries, the Northeast has a wide range of potential feedstocks for ethanol production. In addition to analyzing corn and corn stover, NYSTEC assessed the potential to utilize a wide range of feedstocks that are available in the region. These include not only other biomass feedstocks but also waste products from processing of agricultural crops.

Feedstocks can be separated into two major categories: starch based and biomass. Starch-based feedstocks include corn and most processing wastes. These feedstocks are converted to ethanol through a traditional fermentation process that removes sugars and ferments them to yield ethanol and carbon dioxide. Biomass feedstocks include corn stover, paper-mill wastes, hay, and grasses. Biomass feedstocks have not yet been converted to fuel ethanol in a production-scale facility. However, promising new technologies, like that developed by NREL, are coming to the forefront of the ethanol industry. By using a process that employs cellulase enzymes to break down the cellulose in biomass feedstocks for conversion into ethanol, these technologies promise to make a whole new array of lower-cost feedstocks available to the fuel-ethanol production industry. Many biomass feedstocks are currently not highly valued for other processes. Some are waste products. Therefore, biomass-to-ethanol processing may hold the key to achieving economies capable of overcoming the continued reliance of the ethanol industry on federal subsidies.

For each feedstock, NYSTEC examined a number of factors — including quantities available, purchasing costs, transportation costs, and composition. Noting the strong potential that exists in the Northeast to expand feedstock production, NYSTEC also studied former agricultural lands that have reverted to forests or uncultivated fields since 1969. These lands may be available for a return to income-producing status to grow additional feedstocks for use in producing ethanol.

1.2 Feedstock Quantities

Feedstock data was collected from a wide variety of sources. Data on feedstock quantities was mainly gathered from New York State agricultural statistics (see Table 1). Feedstocks are generally supplied to an ethanol plant from within a 35- to 75-mile radius of the plant. For this study, NYSTEC limited feedstock usage to feedstocks found within the four counties that make up the majority of land within 50 miles of the grain processor, Robbins Corn and Bulk Service (RCBS). NYSTEC designated this area the 'North Country Region,' which encompasses Jefferson, Lewis, Oswego, and St. Lawrence counties in upstate New York. The production of corn and other feedstocks, as well as the amount of available land, were also quantified on a statewide basis for comparison purposes.

1.3 Feedstock Composition

The data on the composition of the feedstocks was gathered through review of literature, which included research reports, textbooks, etc., and through telephone interviews with experts from the industry. See Appendix A (Feedstock Composition) for a complete assessment.

Table 1, Feedstock Production Quantities (1993-1998 Average Yield)

Feedstock Type	Robbins Corn and Bulk Service (RCBS)	North Country Region	New York State
Brewery Solids (dry tons)	0	0	2,901,690
Cheese Whey (dry tons)	0	74,179	219,853
Corn (tons)	1,962	69,185	1,859,200
Corn Silage (tons)	1,246	1,202,420	7,779,200
Corn Stover (tons)	1,339	49,720	1,208,000
Fruit Pomace (wet tons)			
Apples	0	0	46,132
Cherries	0	0	1283
Grapes	0	0	77,195
Papermill Residue (wet tons)	0	151,000	643,000
Straw (tons)	212	2,978	294,740
Grass (tons)	750	354,740	1,848,000
Vegetable Waste (wet tons)			
Beets	0	0	17,045
Cabbage	0	0	19,240
Carrots	0	0	8,218
Peas	0	0	3,767
Snap Beans	0	0	14,281
Sweet Corn	0	0	149,856
Willow Biomass (dry tons)	0	0	230
Winery Waste (dry tons)	0	0	18,853

1.4 Feedstock Costs

Cost data for farm feedstocks is based upon discussions with local farmers and is supported by data from New York State agricultural statistics. Cost data for non-farm feedstocks is based on discussions with feedstock producers, state government personnel, and research data. Transportation costs for most feedstocks are included in feedstock costs. For feedstocks that did not have transportation costs included, those costs were estimated based upon data provided by local farmers and by the U.S. Department of Agriculture. See Appendix B for feedstock costs, to include transportation costs.

Data on agricultural land availability was based on the New York State Census of Agriculture and on a Cornell University report titled, "The Return of Agricultural Lands to Forest." Based on data extrapolated from these sources, NYSTEC created reliable estimates of acres of land removed from agricultural production between 1969 and 1997.

For each feedstock, data sheets that identify the data sources and contain information about production in the regions and costs are provided in Appendix B (Feedstock Cost).

1.5 Individual Feedstocks

1.5.1 Corn

Corn is a primary feedstock in most ethanol production plants in the United States. The corn-to-ethanol production process uses a well-documented and proven technology to produce over 860 gasoline-equivalent million gallons of ethanol per year for the oxygenate, additive, and alternative-fuel markets. New York's grain-corn production in 1997 totaled 75.4 million bushels, up 22.8% from the 1996 level. As a result, New York State had a feed-grain surplus in 1997 after running deficits for many years. Changes in the State's dairy industry have created the need for new markets for corn. The decline in the number of grain-consuming animal units and in the quantity of grain fed per animal may require farmers to curtail corn production and result in a concurrent reduction in farm income. Ethanol production within New York State would increase the demand for corn, provide a promising new market, and stimulate farm income.

The feedstock data sheets in Appendices A and B provide detailed analysis of corn production, corn costs, and chemical composition. As a key feedstock for an ethanol plant, corn is a commodity that experiences price variations that must be carefully monitored. NYSTEC studied the price of corn over the last five years based on data from the NY State Agricultural Statistics. Corn prices spiked significantly in 1995 due to worldwide shortages. After interviews with the corn growers and detailed study team discussions, a corn price of $2.35 per bushel was established as the baseline price for the ethanol plant. Although this price is higher than the price offered for mid-west corn, reflecting the higher farming costs in New York, this price is lower than the five-year average corn cost derived from analysis of the agricultural statistics. This price reflects a realistic assessment of the prices that corn growers expect to receive for their crop for the foreseeable future.

1.5.2 Corn Stover

Corn Stover was identified as a primary biomass feedstock for this study. Corn stover consists of the parts left over from corn harvesting. Corn stover is a biomass feedstock that has no current economic value. Most stover is left on the farmland after corn harvesting. A large portion of this stover can be collected for producing a low-cost ethanol fuel, while the small remainder can be left on the fields as a soil-nutrient source. As the quantity of corn stover is directly related to corn production, NYSTEC developed estimates of corn stover production from data on the production of corn statewide.

1.5.3 Other Biomass

Other biomass feedstocks reviewed during this study include straw, grass, paper sludge, and dedicated feedstock (willow biomass). Production levels for these feedstocks were reviewed statewide and for the North Country Region.

Straw and grass are grown in abundant quantities in upstate New York. Grasses include timothy, broome, and oat. Straw includes barley, wheat, and oat. These feedstocks are currently used or sold as low-cost products in New York State. Some of these products are grown on land that once grew corn and other higher-value agricultural products. With the decline in demand for the higher-value products in New York, more marginal-quality lands have been converted into grass and straw farmlands. These feedstocks present options as low-cost feedstock inputs to the ethanol plant.

Paper sludge (paper-mill waste) is rich in cellulose and has a potential for ethanol production. A Wisconsin study determined that pulp and paper-mill sludges have an ethanol-yield potential of 51 to 74 gallons of ethanol per dry ton. Paper-mill wastes have traditionally been disposed of in landfills or spread on fields. Besides producing ethanol (a beneficial commodity), use of this feedstock yields the environmental benefit of saved landfill space and the economic benefit of reduced waste-disposal costs. Paper-mill waste is comprised of a number of types of waste streams. In 1993, the Pulp and Paper Industry's National Council for Air and Stream Improvement (NCASI) classified the solid-waste streams into primary sludge, secondary sludge, combined sludge, flume grit, screen rejects, wood waste, pulper rejects, lime mud, lime grit, and green liquor dregs. The sludges and the wood wastes from these processes show the most potential for conversion to ethanol. Studies have shown that primary sludge has high cellulose content. However, paper-mill wastes result from a variety of different processes and, therefore, have varying contents of ash, inorganic material, and cellulose.

Dedicated feedstock willow biomass is a new agricultural crop being researched by the State University of New York, College of Environmental Science and Forestry. Willow biomass plantations in New York are adapted from a commercially operational system in Sweden, where more than 35,000 acres of willow energy plantations have been established. Such plantations plant double rows, approximately 6,200 trees/acre, following complete site preparation, including herbicide application, plowing, and disking. Trees are planted in spring as unrooted, 10-inch-long cuttings (sticks), using planting machines developed in Sweden and modified for local conditions. Weed control, using a combination of mechanical and chemical techniques, is essential during the first year of establishment. Trees are cut after the first year to promote sprouting. Harvesting occurs every three to four years in the winter after leaves have fallen. Following each harvest, the plants re-sprout. The perennial nature of the crop means that erosion potential and pesticide application are reduced compared to more common annual agricultural crops. Willow biomass is a clean, versatile wood-energy source with potential for use as an ethanol crop.

Biomass feedstocks may provide the largest quantity and lowest-cost opportunity for large-scale ethanol-processing facilities in New York State. These alternative feedstocks may help an ethanol facility cope with the seasonality issue of corn and corn stover.

1.5.4 Processing Wastes

New York State has additional feedstock groups readily available from its food-processing industry. These alternative feedstocks could help an ethanol operation address the financial/seasonal challenges of its operation, while helping meet the environmental challenges of waste disposal. Seasonal wastes are available for short periods of time when specific crops are harvested and processed. NYSTEC surveyed food-processing and beverage industries that generate various residual solids as potential feedstock suppliers for ethanol. Table 2 lists the initial assumptions of statewide availability of food-processing wastes.

The study team evaluated wastes from the processing of many farm crops in New York State, then selected those that were the most appropriate feedstocks for ethanol production. NYSTEC initially studied agricultural processing wastes that included corn silage, brewery waste, and cheese whey; waste from processing sweet corn, cabbage, beets, snap beans, carrots, and peas; and pomace from grapes, apples, cherries and winery wastes. NYSTEC addressed the amount of crop waste that is generated based on the amount of feedstock crops that are harvested from farms in each of the three study regions.

Table 2, Statewide Food-Processing Wastes

Type of Waste	Available Quantity
Fruit Pumice	
Apples	75,000 tons
Cherries	2,000 tons
Grapes	31,000 tons
Vegetable Waste	
Snap beans	23,000 tons
Beets	33,000 tons
Cabbage	28,000 tons
Carrots	7,000 tons
Sweet Corn	75,000 tons
Peas	1,500 tons
Cheese Whey	3,200 tons
Brewery Solids	TBD

The processing wastes reviewed are most often disposed of in landfills or spread over land. Regulatory restrictions on the disposal of these wastes — as well as a shortage of space and locations for spreading wastes over land — may enable ethanol processors to purchase wastes at low prices or be compensated for removing them from the processors' plants. An estimate of processing waste composition is provided on the feedstock data sheets in Appendix A.

1.6 Available Land

New York has abundant land resources that could easily be brought into feedstock production. Increased efficiency and a contracting dairy industry in New York State have caused a decrease in cultivated acreage. For example, corn acreage in 1997 was 1.2 million acres — down from a high in the State of 1.4 million acres in 1981. In 1945, farm operators in New York owned or leased 17.6 million acres. In 1992, that figure had declined to fewer than 7.5 million acres. The 1959 Federal Census of Agriculture showed farmland (all uses) at 13,480,000 acres and cropland at 7,120,000 acres. NYS Department of Agriculture and Markets statistics indicate that, in 1997, total farmland acreage was 7,700,000 and cropland was 4,910,000. While some of this land has been developed, most remains open and available for new feedstock production.

Table 3 outlines the result of NYSTEC's analysis of available farmland in the North Country area (as well as in eighteen other upstate New York counties that could provide feedstock to an ethanol production facility or could replace feedstock that is diverted from current uses to ethanol production). Available farmland was defined as land that has reverted from farm use to natural forestation. Using data from the Census of Agriculture and a Cornell

University report, "The Return of Agricultural Lands to Forest," NYSTEC created reliable estimates of land that reverted from agricultural production between 1969 and 1997. The table is meant as a guide to land available for growing feedstock resources within the study area. This data does not account for the portion of land that is currently enrolled in federal protection programs such as the Conservation Reserve Program (CRP).

Table 3, Land Lost (acres) from Farming to Reforestation, by County, 1967 to 1997

County	Total	Active Crop-lands in 1997	Reduction 1969 to 1997	Reforested Factor	Estimated Reforested 1969 - 1997
Statewide	24,600,000	4,722,143	1,358,000	0.699	948,964
Cayuga	445,000	192,590	-1,500	0.909	-1,363
Chenango	576,667	104,034	28,600	0.953	27,257
Cortland	322,500	66,864	23,500	0.921	21,645
Fulton	320,000	21,623	7,800	0.916	7,142
Hamilton	1,090,000	n/a	n/a	0.804	n/a
Herkimer	916,667	90,171	31,600	0.826	26,088
Jefferson	827,000	193,684	66,300	0.919	60,939
Lewis	827,000	101,521	18,500	0.880	16,284
Madison	422,500	120,577	20,700	0.919	19,022
Monroe	432,500	89,730	34,000	0.530	18,007
Montgomery	260,000	104,553	13,500	0.911	12,302
Oneida	784,000	138,645	53,500	0.819	43,823
Onondaga	508,000	111,557	29,500	0.713	21,020
Ontario	417,500	153,765	24,300	0.903	21,941
Oswego	617,500	59,069	28,100	0.924	25,960
Otsego	650,000	116,366	51,700	0.922	47,645
Schoharie	400,000	70,120	28,800	0.956	27,545
Seneca	210,000	97,052	-2,200	0.908	-1,997
St. Lawrence	1,770,000	220,183	84,300	0.888	74,881
Tompkins	307,500	63,961	17,500	0.920	16,092
Wayne	387,500	125,278	37,300	0.860	32,095
Yates	220,000	77,370	8,800	0.952	8,382

The first column of the table shows the total acreage of land in each of the counties. The second column shows the total active croplands acreage in 1997, while the third column shows difference between the total acreage that was available in 1969 and that available in 1997. While all of the acreage from this third column is no longer farmed, some of that land is now developed as commercial or residential land. To account for this difference, data was scaled based upon a ratio of reforested land to total land made available. Because this ratio was not available for the selected time period (1969 to 1997), a ratio was created from development rates between 1910 and 1992. This ratio was then applied as a factor to the data on farmland reduction to create the estimated reforested acreage that is presented in the final column.

1.7 Selected Feedstocks

Utilizing the simulation provided by NREL, NYSTEC's technology subcontractor, Raytheon Engineering and Constructors, evaluated data on potential New York State feedstocks. Corn stover, hay, and straw were the most promising feedstocks and were recommended as the feedstocks for the plant. Additional testing and evaluation of these feedstocks is needed, however, to validate the assumptions made in the simulation and may include:

- A more detailed chemical analysis for modeling in the simulation,

- Further definition of ash content of the feedstocks, and
- The need to test feedstocks to verify handling characteristics.

Its large water content, which would require wastewater handling, makes corn silage impractical as a potential feedstock. Additionally, it is needed and produced to serve as a dairy feed in New York State. Sweet corn has a similar problem because it increases the wastewater flow rate an estimated 50% for a three-month period. The other feedstocks (cabbage, beets, beans, grapes, apples, carrots, peas, wine waste and cherries) were not attractive choices due to the relatively small amounts of alcohol produced and the large amounts of wastewater derived from production. Apples have an additional drawback inasmuch as the pectin content would require an increase in the pump motor horsepower. The fruits (grapes, apples, and cherries) would require pasteurization to reduce the formation of acetic acid from fermentation before being loaded for transport to the plant. Higher acetic acid content would increase the ion exchange and overliming system sizes. However, these feedstocks could become more feasible given an appropriate waste disposal credit fee structure.

Additional research is needed to determine if paper-mill residue is a favorable material and is sufficiently available in New York State for use as a feedstock. Data suggests that 263,000 tons of the 643,000 tons produced annually are used by the industrial coal stoker market and may include the lower-ash-content portions that would be the same materials needed for the ethanol plant. The high ash deinking mill stock is not desirable due to the higher ion exchange and overliming capacity requirements, and due to the higher fouling rates for the boiler burning the waste solids. Quantities of bark and woodchips would be desirable as a feedstock component.

2. Facility Description

2.1 Grain Processing Facility

Robbins Corn and Bulk Service (RCBS), located in Sackets Harbor NY, was evaluated as the existing grain-processing facility. RCBS sits on five acres and is able to process 10,000 bushels of grain a day. The facility consists of processing/grain-drying equipment, six storage structures, scales for weighing trucks, and a roaster for drying grains. RCBS is located four miles from Interstate 81, five miles from rail lines, and twelve miles from the Development Authority of the North Country Regional Solid Waste Facility.

Raytheon Engineering and Constructors, NYSTEC's architectural and engineering firm subcontractor, evaluated the RCBS operation for synergies with a biomass-to-ethanol facility. The results of Raytheon's evaluation are detailed in Appendix C, Section I (Robbins Corn and Bulk Service Evaluation, pages C5-C7).

Although efficient and effective in its operation, RCBS's size, particularly in storage capacity, is not large enough to achieve any economic synergies with a collocated biomass-to-ethanol facility. However, as noted in Section 1, sufficient feedstocks exist or could exist (via farmland put back into production) for biomass-to-ethanol processing in New York. Therefore, the limiting factor of a collocated biomass-to-ethanol facility is not in the feedstock availability, but in the insufficient size of the existing grain operation.

2.2 Process-Related Requirements

Raytheon Engineering and Constructors, based on the process-flow description provided by NREL and on the feedstock data provided by NYSTEC (see Section 1), evaluated and designed two biomass-to-ethanol plants. The two plants differ only in that one includes enzyme-production capabilities while the other assumes the required enzymes will be purchased. The specifications are contained in Appendix C, Sections II H (Conceptual Plant Layout) and II I (Process Flow Diagrams). Each of these two biomass-to-ethanol plants has a capacity of 60 million gallons per year (60 MGPY).

Raytheon Engineering and Constructors, based on direction from NYSTEC, also evaluated and designed a corn-to-ethanol plant. The specifications are contained in Appendix C, Section III F (Process Flow Diagrams). This corn-to-ethanol plant has a capacity of 30 MGPY.

2.3 Capital and Operating Costs

Raytheon Engineering and Constructors developed capital and operating costs for the island of process equipment for both plant types (biomass and corn). Capital costs are in Appendix C, Sections II E (biomass-to-ethanol plants) and III C (corn-to-ethanol plant). Operating costs are in Appendix C, Sections II F (biomass-to-ethanol plants) and III D (corn-to-ethanol plant).

2.3.1 Capital Costs

As indicated above, two differing 60-MGPY biomass-to-ethanol plant configurations were examined. The first included equipment and process for producing enzymes; the second did not include enzyme production.

In the case of the biomass plant with enzyme production, the total capital cost for the island of process equipment is $56,184,150. In the case of the biomass plant without enzyme production, the total capital cost is $51,771,150. The differential ($4,413,000) between the total capital costs of the two plants is the enzyme production capability.

In the case of the corn plant, the total island of process equipment capital cost is $15,127,000.

2.3.2 Operating Costs

The operating costs for the three plant configurations (biomass with enzyme production, biomass without enzyme production, and corn) were also derived. The operating costs include both labor and non-labor aspects.

From the labor perspective, a differential is seen based on whether the biomass plant produces enzymes or not. The biomass plant with enzyme production has an annual labor cost of $6,537,450 (including benefits), while the biomass plant without enzyme production has an annual labor cost of $6,094,650 (also including benefits). Therefore, enzyme production has a labor cost of $442,800 per annum.

Including labor costs, the operating costs for the biomass-with-enzyme-production plant total $47,232,067.

The corn-to-ethanol plant has a labor cost of $5,147,550 and a total operating cost of $54,910,292. Note that the annual operating costs of the 60-MGPY biomass plant are $7,678,225 less than the costs for the 30-MGPY corn plant. The main components of this differential are feedstock costs ($29,400,000 for the biomass plant versus $33,600,000 for the corn plant) and electricity (zero for the biomass plant versus $2,620,800 for the corn plant).

The cost comparisons for these three plant configurations are shown in Table 4.

Table 4, Capital and Operating Costs

	Biomass with Enzyme Production	Biomass without Enzyme Production	Corn
Capital	$56,184,150	$51,771,150	$15,127,000
Labor	$6,537,450	$6,094,650	$5,147,550
Operating Cost (including labor)	$47,232,067	$TBD	$54,910,292

3. Capital and Operating Cost Refinement

3.1 General Discussion

Raytheon Engineering and Constructors refined the capital and operating costs for both plant types (biomass and corn) based on site-specific criteria. Capital cost refinement, including appropriate direct and indirect costs, is detailed in Appendix C, Sections II D (biomass-to-ethanol plant) and III B (corn-to-ethanol plant). Operating costs remain the same and are detailed in Appendix C, Sections II F (biomass-to-ethanol plants) and III D (corn-to-ethanol plant).

3.2 Refinement Results

3.2.1 Capital Costs

Two differing 60-MGPY biomass-to-ethanol plant configurations were examined. The first included equipment and process for producing enzymes, and the second did not include enzyme production.

In the case of the biomass plant with enzyme production, the total capital cost for the plant is $230,344,105. This cost includes the island of process equipment and the following direct and indirect cost elements:

- Site Improvements
- Earthwork
- Concrete
- Structural Steel
- Process Equipment
- Piping
- Insulation
- Instrumentation & Controls
- Electrical
- Painting
- Buildings & Architectural
- Start-up, Testing, & Training
- Temporary Facilities
- Construction Equipment, Tools, & Supplies
- Field Staff & Legalities
- Indirect Field Cost

- Engineering (Home Office)
- Taxes
- Insurance
- Permits
- Craft Casual Overtime
- Contingency
- Construction Management Fee

In the case of the biomass plant without enzyme production, the total capital cost is $212,253,235. This cost includes the elements just listed. The total capital cost for enzyme production is the differential ($18,090,870) between the costs of these two plants.

In the case of the corn plant, the total capital cost is $70,193,000. This cost includes the elements just listed.

3.2.2 Operating Costs

The operating costs for the three plant configurations (biomass with enzyme production, biomass without enzyme production, and corn) remain as were described in Section 2.3.2. These operating costs include both labor and non-labor aspects.

Table 5 below includes Table 4 data for the island of process equipment and has been updated to reflect the addition of direct and indirect costs.

Table 5, Refined Capital and Operating Costs

	Biomass with Enzyme Production	Biomass without Enzyme Production	Corn
Capital	$56,184,150	$51,771,150	$15,127,000
Labor	$6,537,450	$6,094,650	$5,147,550
Operating Cost (including labor)	$47,232,067	$TBD	$54,910,292
Refined Capital Cost	$230,344,105	$212,253,235	$70,193,000

4. Financial Pro Forma Preparation

4.1 The Model

If a project's potential capital and operating costs, product prices, and rates of return for an entire time horizon were known with certainty, an economic and financial evaluation would be easy to accomplish. Investors could determine which alternative yielded adequate rates of return, and make appropriate investment decisions. However, it is not possible to know these numbers with certainty before the plant begins operation. Ethanol production costs are particularly difficult to quantify in a pro-forma, because they rely on the purchase of feedstock(s) with fluctuating prices. The ethanol product price also fluctuates, but this fluctuation is due to other factors such as gasoline costs that are only minimally correlated with the cost fluctuations in the input parameters. Uncertainties in key variables are quite likely to create significant fluctuations in potential rates of return. Therefore, the pro-forma model used must be able to assess and comprehend the levels of change that are created by uncertainty in specific variables.

For this project, NYSTEC developed a two-step process to create a baseline pro-forma and a more detailed sensitivity analysis. Most of the financial data — including capital costs, material costs, and labor costs — was provided by Raytheon Engineering and Constructors in its report to NYSTEC (Appendix C). NYSTEC refined this pro-forma through application of a standard pro-forma format. The NYSTEC Team created a detailed baseline pro-forma using Spreadware's high-quality commercial-off-the-shelf (COTS) pro-forma software package as the basis (see Appendix D). NYSTEC developed adjustments to standardize the software package for a large ethanol-production facility. These adjustments were based on the insights NYSTEC gained during the course of the study.

It is often assumed that production and investment decisions are made with perfect knowledge about the future and are based on a desire to maximize the present value of future net revenues. Based on the expected uncertainties, the pro-forma focuses on discounted cash flow as the basis of long-term economic viability. By calculating the current dollar (discounted) value of future profits, a realistic return on investment can be determined. This return on investment must be assessed in conjunction with risk level. Larger capital investments and more experimental technology provide larger risks for investors. At this time, full-scale biomass-to-ethanol production requires both a large capital investment and a reliance on technology that has not been proven at a full production scale.

The anticipated New York State ethanol industry has one element that is not captured in the discounted cash-flow and risk-assessment data within a standard pro-forma. A large ethanol industry will have a positive net effect on the depressed rural NYS economy. This is likely to provide further encouragement for participation in a farmer-owned ethanol-production operation. Additional profits will revert back to farmer investors through the development of a more stable overall farm economy. These advantages are not quantified in this model, but they would likely accrue to any farmer-investor group, and to the farm community as a whole, should an ethanol plant be built. The advantages that this industry may provide to State government are quantified and discussed in the sensitivity analysis section (Section 5).

4.2 Pro-Forma Design

The baseline pro-forma outlines one cost scenario for developing a biomass-to-ethanol production plant with enzyme production at RCBS. The objective of the pro-forma is to estimate operating costs based on the best data available.

All costs contained in the attached pro-forma pages (capital costs, materials, labor, taxes, revenue, and transportation) are in 1999 dollars as NYSTEC believes that inflation will effect all these areas equally. By estimating costs based on a single-year dollar value, we were able to provide straight-line estimates of income and operating expenses. Although a series of technical and political issues can be expected to impact the cost of ethanol and the cost of inputs to the process, these will be reviewed in the Sensitivity Analysis phase of the project. The debt service page and the income statement are provided with charts in two separate formats. One format is in baseline year (1999) dollars, while the other is in actual-year dollars based upon an annual 3% inflation rate.

The first two years of the financial pro-forma are considered to be construction years. The plant is estimated to have an 18-month construction and ramp-up phase with periodic testing and shutdowns. During the following six months, some testing and tuning will be required before the plant reaches full capacity. By 'Operation Year 1,' the third year in the pro-forma, it is assumed that the plant is running at full capacity.

4.3 Analysis of Pro-Forma Components and Inputs

The complete baseline financial pro-forma is provided in Appendix D. Project costs in the pro-forma are detailed by category and outlined in the sections that follow.

4.3.1 Capital and Site Review

The first page of the pro-forma reviews the up-front costs as outlined by Raytheon Engineering and Constructors. The total capital and site costs are provided as the input to the debt and depreciation calculations in the next page. Direct field costs for construction of the 60-million-gallon-per-year biomass-to-ethanol facility total $159.3 million. This cost includes construction equipment, tools, supplies, and temporary facilities.

Additional field costs of $4.7 million are incurred to cover field staff and legalities. Start-up and testing are not included in these costs, but are covered through calculation of the losses of product for sale within the two construction years. Engineering costs total $13.9 million and overtime, permits, and insurance add an additional $1.6 million. Taxes are assumed to be waived for the purchase of construction materials and equipment, as is the standard for most large industrial job-creation projects. A contingency has been planned equal to 25.9% of total field and home office costs. It is assumed that the contingency covers minor items not included in the equipment list, unknown equipment requirements, unknown site requirements, and other unidentified costs. It is also assumed that the contingency will cover all on-site costs.

The estimate does not include the cost of offsite roads, railroads, and utility connections. Such off-site costs are assumed to be covered by the appropriate utility, agency, or railroad that would benefit from the economic impact of providing these upgrades. With the inclusion of a $4.8 million construction management fee, the total capital cost comes to $230.3 million.

4.3.2 Debt Schedule

The second page of the pro-forma shows the debt-repayment estimates. The debt includes an additional 10% of construction costs for working capital. For the base case, we assume that there is no up-front capital. Although most similar plant construction would include up to 30% up-front equity, these funds would not be available by an entity to build this plant in New York at this time. Other debt-to-equity ratios are reviewed in the sensitivity analysis.

The debt payments are based on a 15-year loan at an interest rate of 11%. Rates and terms were based on estimates by Raytheon Engineering and Constructors. Long-term debt is calculated and summarized in actual-year dollars. At the bottom of the debt-schedule page, these numbers are converted into 1999 dollars. Debt levels during the construction years are based upon the level of completion of plant construction and equipment orders. During the first construction year, only the loan fees will be collected, as outlined in the Generally Accepted Accounting Principles (GAAP).

The plant depreciation is provided on a straight-line basis over 20 years, based upon the standards of the GAAP. Start-up expenses are estimated to be in the range of $1.4 million and are amortized over the five years beginning in the start-up year, as per GAAP.

4.3.3 Materials

Raytheon Engineering and Constructors provided estimated material costs as outlined on the third page of the pro-forma. For the baseline case, it is assumed that material costs will remain constant, excluding inflationary effects. The delivered cost of biomass is estimated at $35 on average. This page also includes all operating chemical, process water, natural gas, disposal costs, maintenance materials, and miscellaneous incidentals. Although the plant will not produce product at 50% of capacity in the second construction year, it is assumed that 50% of supplies and feedstock will be required. This accounts for the inevitable bad batches, start-up challenges, and ramp-up situation that must be accounted for within this year.

4.3.4 Labor

Based on the estimates provided by Raytheon Engineering and Constructors, the plant will require 97 production employees and 7 administrative employees. Labor and fringe rates were provided by Raytheon Engineering and Constructors. Production employees average $50,103 per year and administrative employees average $65,000 per year. All employees require an employer contribution to benefits that is equal to an additional 23% of salary. These values are based on similar operations elsewhere. It is assumed that labor costs will run at 44% of full costs during the hiring and ramp-up period in the second construction year.

4.3.5 Tax Impacts

The fifth page of the pro-forma is provided to analyze federal, State, and local tax costs as well as State and local government incentives. For this baseline, we included a rate of 35% of revenues as a federal tax. Because federal taxes are not due until all losses from previous years of operation are written off, there are no federal taxes until the cumulative total bottom line from plant operations becomes positive. This does not occur until the twentieth year of operation.

State and local taxes are assumed to be offset over the first ten years by any State and local incentives provided. Property taxes are assumed to be waived for the first five years and to be reduced to $9000 in subsequent years. This is based on the average type of incentives provided by the State of New York. The effect of additional incentives will be reviewed in more detail in the sensitivity analysis phase of this project.

State benefits are realized and incentives granted through the assessment of potential new tax revenue from job creation. NYSTEC collected data on these effects from the Public Policy Institute of New York, and provided some preliminary data based upon the direct plant jobs and their induced multiplier effects. These effects are quantified on the tax impacts page. Additional detail, including estimates of indirect non-farm jobs and their induced multiplier effects, will be discussed in the sensitivity analysis section of this report.

4.3.6 Revenue Forecast

The sixth page of the pro-forma identifies the proposed sale price of products. It is assumed that this process will not produce any co-products for on-farm sales, but will provide a co-product that can be burned for use in producing electricity for on-site and off-site use. CO_2 produced by the process will be sold at an estimated price of $7 per ton. Electricity sale prices are based on estimates from Niagara Mohawk Power Corporation. CO_2 prices are based on averages provided by Gaylord Engineering. The ethanol sale price was set at $1.15 per gallon at the plant gate. This price does not account for product transportation costs.

4.3.7 Income Statement

The seventh page of the pro-forma ties together the figures from the other pages and presents a total picture of the financial status of the facility. This is done through five separate types of analysis. First, this page provides a summary, in baseline 1999 dollars, of the income and expenses from each previous page. Second, using the 3% annual inflation rate, the income and expenses are reviewed in the actual-dollar values that they are predicted to be in any given year. Third, a review of the value of capital equipment through depreciation is provided. Fourth, an analysis shows the net present value of profit and capital investments. This analysis allows financial supporters to review the return on investment. This baseline plant requires an initial investment of $253.4 million to cover capital costs and working capital during construction and sees a return of $604,074 in present value dollars at the end of the twentieth year. This is not a reasonable return for this size of an investment, for it provides barely 0.3% return over the rate of inflation. Fifth and final, expenses are broken down to show their cost per gallon of denatured ethanol in the first full-scale year of production.

4.3.8 Summary of Transportation Costs

The final page of the pro-forma outlines the costs to transport feedstock from the farm to the plant, and finished product from the plant to the consumer. This is not a standard pro-forma page, and therefore is provided as an addendum to the pro-forma for informational purposes only. Trucking costs from the farm to the plant are estimated at $7.35 per ton, based on local costs charged for 35-mile transportation of farm goods. This is based upon 35 miles being the average transportation distance from any point within 50 miles of the plant to the actual plant site. Rail costs from the plant to the consumer are estimated at 4.5 cents per gallon, based on the cost of tank car lease and transportation cost estimates provided by the Mohawk, Adirondack and Northern Railroad for transport from upstate New York to the greater New York City area. Costs to transport feedstock have been included in the feedstock costs.

4.4 Conclusions from the Baseline Pro-Forma

In the first full year of production, the ethanol plant sees a total loss of $19.1 million. The plant starts reporting yearly income beginning in Year 10, and sees a significant jump in income with the completion of the depreciation schedule in Year 20. By Year 20, the plant has an annual income of $38.6 million. At the end of ten years, the present value of all losses totals over $118.1 million. In Year 20, the plant offsets all losses and pays federal tax for the first time. At the end of this twentieth year, the present value of all profits is just over $600,000.

Although a small profit is shown over the 20 years, it does not justify the large up-front capital investment. This can clearly be determined from the Net Present Value Analysis on the Income Statement page of the pro-forma. The baseline plant requires an initial investment of $253.4 million to cover capital costs and working capital during construction and sees a return of $604,074 in present value dollars at the end of the twentieth year. This provides a return-on-investment after 20 years that is barely 0.3% over the annual effects of inflation. Therefore, this baseline scenario will be unable to secure investments for constructing the plant.

5. Sensitivity Analysis

5.1 Introduction

NYSTEC developed the pro-forma profile of the capital, operating, sales, and profit figures from the ethanol facilities. Because of the unique nature of a large number of parameters that drive the ethanol industry — parameters that include feedstock cost, ethanol price and co-product prices — the sensitivity analysis was developed to more carefully assess the risk and return-on-investment opportunities that are available for a biomass-to-ethanol processing plant.

NYSTEC used the Agricultural Systems Economic Evaluation Development (ASEED) model to analyze the effect of price fluctuations in capital costs, debt costs, transportation, labor, and feedstock costs on the feasibility of ethanol production. Detailed analyses were conducted in nineteen different areas. In many of these areas, a number of deviations from the baseline were assessed.

The results of all sensitivity analysis steps are summarized in Table 6 (on the following page). This table outlines each scenario, the action taken to change the baseline cost, and the effect on various key cost elements in the pro-forma. These cost elements include, profit in year 1, profit in year 10, profit in year 20, construction cost, total debt (calculated as construction cost plus contingency minus up-front equity), present value return-on-investment at year 10, and present value return-on-investment at year 20. Because this pro-forma is developed to address the many complicated cost elements that are required for financial feasibility, some results may appear to be counter-intuitive. For example, some cases that would be likely to increase overall profitability (for example: Case 09a, reduced landfill costs) result in a reduction in profit in the twentieth year. (In the cited case, the peculiar result is due to the earlier break-even point of the more profitable operation.) While the base case only begins to assess federal taxes in the twentieth year, a case that becomes profitable earlier will require full federal tax payments before the twentieth year.

The scenarios and results from Table 6 are explained in more detail in the sections below.

5.2 Sensitivity Analysis Results

5.2.1 On-Site Costs

Estimated potential on-site costs at Sackets Harbor could add to project cost. Although Raytheon included contingency costs to cover most on-site expenses, these contingencies did not include the cost of running new rail, power, and water lines to the site. If these are not covered as part of an economic-development benefit, they could add up to $3 million on top of the current construction cost estimate. The effect of that additional $3 million cost was assessed.

This added cost — additional principal plus interest from the $3 million up-front expense — would result in a reduction of $5.1 million in total return on investment.

5.2.2 Start-up Problems

Estimated costs of unforeseen start-up problems that have not been quantified in the engineering cost estimates could also negatively impact the project. Start-up problems are

Table 6, Sensitivity Analysis Results (Effect on 60 MGY Biomass to Ethanol Plant)								
Scenario	Change Created by Scenario	Year 1 First Full Scale Year Profit	Year 10 Profit	Year 20 Profit	Construction Cost	Total Debt	Ten Year Present Value Profit	Twenty Year Present Value Profit
BASELINE SCENARIO		($19,075,236)	$607,932	$38,621,622	$230,344,105	$253,378,516	($118,199,159)	$604,074
01a. On Site Cost Problems	Increase On-Site Construction Costs by $3 million	($19,588,236)	$244,372	$39,319,452	$233,344,105	$256,678,516	($122,324,953)	($4,446,292)
Change from Baseline ------------>		($513,000)	($363,560)	$697,830	$3,000,000	$3,300,000	($4,125,794)	($5,050,366)
02a. Start Up Problems	Reduce Const. Year 2 Ethanol Sales by $3.4 million	($19,075,236)	$607,932	$39,319,452	$230,344,105	$253,378,516	($121,599,159)	($2,397,963)
Change from Baseline ------------>		$0	$0	$697,830	$0	$0	($3,400,000)	($3,002,037)
03a. Extra Permit Costs	Add $250,000 to the cost of construction permitting	($19,117,986)	$577,636	$38,900,270	$230,594,105	$253,653,516	($118,542,975)	$308,956
Change from Baseline ------------>		($42,750)	($30,297)	$278,649	$250,000	$275,000	($343,816)	($295,118)
04a. Five percent interest rate above inflation	Reduce interest rate to 5%	($11,337,987)	$6,193,534	$25,552,120	$230,344,105	$253,378,516	($52,090,118)	$51,583,678
Change from Baseline ------------>		$7,737,249	$5,585,602	($13,069,501)	$0	$0	$66,109,041	$50,979,604
04b. Zero percent interest rate above inflation	Reduce interest rate to 0%	$1,557,429	$9,042,875	$25,552,120	$230,344,105	$253,378,516	$32,746,320	$128,785,224
Change from Baseline ------------>		$20,632,665	$8,434,943	($13,069,501)	$0	$0	$150,945,479	$128,181,150
05a. 9:1 Debt to Equity Ratio	Include 10% up-front equity in the plant	($16,541,451)	$2,098,611	$25,552,120	$230,344,105	$253,378,516	($99,646,842)	$14,602,338
Change from Baseline ------------>		$2,533,785	$1,490,678	($13,069,501)	$0	$0	$18,552,317	$13,998,264
05b. 2.33:1 Debt to Equity Ratio	Include 30% up-front equity in the plant	($11,473,881)	$5,079,968	$25,552,120	$230,344,105	$253,378,516	($62,542,208)	$42,598,867
Change from Baseline ------------>		$7,601,355	$4,472,035	($13,069,501)	$0	$0	$55,656,950	$41,994,793
06a. Five year depreciation	Depreciate plant consturction costs over 5 years	($55,121,685)	$12,623,415	$39,319,452	$230,344,105	$253,378,516	($232,686,724)	($41,784,285)
Change from Baseline ------------>		($36,046,449)	$12,015,483	$697,830	$0	$0	($114,487,565)	($42,388,359)
06b. Ten year depreciation	Depreciate plant construction costs over 10 years	($31,090,719)	$12,623,415	$39,319,452	$230,344,105	$253,378,516	($217,366,250)	($26,463,811)
Change from Baseline ------------>		($12,015,483)	$12,015,483	$697,830	$0	$0	($99,167,091)	($27,067,885)
06c. Twenty-five year depreciation	Depreciate plant construction costs over 25 years	($16,672,140)	$3,011,029	$19,304,069	$230,344,105	$253,378,516	($94,682,194)	$21,648,087
Change from Baseline ------------>		$2,403,097	$2,403,097	($19,317,553)	$0	$0	$23,516,965	$21,044,013

Scenario	Change Created by Scenario	Year 1 First Full Scale Year Profit	Year 10 Profit	Year 20 Profit	Construction Cost	Total Debt	Ten Year Present Value Profit	Twenty Year Present Value Profit
07a. Competative Feedstock Market	Feedstock costs raised to $50 per ton	($31,675,236)	($15,832,210)	$17,225,276	$230,344,105	$253,378,516	($250,499,159)	($257,297,963)
Change from Baseline ------------>		($12,600,000)	($16,440,142)	($21,396,346)	$0	$0	($132,300,000)	($257,902,037)
07b. Use of hay feedstock	Feedstock costs raised to $100 per ton	($73,675,236)	($70,632,684)	($56,421,979)	$230,344,105	$253,378,516	($691,499,159)	($1,118,297,963)
Change from Baseline ------------>		($54,600,000)	($71,240,616)	($95,043,600)	$0	$0	($573,300,000)	($1,118,902,037)
07c. Use of corn and stover together	Feedstock costs raised to $59 per ton	($39,235,236)	($25,696,295)	$3,968,770	$230,344,105	$253,378,516	($329,879,159)	($412,277,963)
Change from Baseline ------------>		($20,160,000)	($26,304,227)	($34,652,852)	$0	$0	($211,680,000)	($412,882,037)
07d. Use of biomass and paper mill waste	Feedstock costs lowered to $18 per ton	($4,795,236)	$12,501,951	$41,828,163	$230,344,105	$253,378,516	$20,615,797	$190,885,074
Change from Baseline ------------>		$14,280,000	$11,894,018	$3,206,542	$0	$0	$138,814,956	$190,281,000
07e. Use of DFSS woody biomass	Feedstock costs raised to $75 per ton	($52,675,236)	($43,232,447)	($19,598,352)	$230,344,105	$253,378,516	($470,999,159)	($687,797,963)
Change from Baseline ------------>		($33,600,000)	($43,840,379)	($58,219,973)	$0	$0	($352,800,000)	($688,402,037)
08a. Cellulose bought from outside producer	Adjust lower construction cost, labor cost, and add new material cost	($45,263,683)	($35,406,042)	($12,026,687)	$212,253,235	$233,478,559	($400,809,854)	($566,453,245)
Change from Baseline ------------>		($26,188,447)	($36,013,975)	($50,648,309)	($18,090,870)	($19,899,957)	($282,610,695)	($567,057,319)
09a. Landspread wastes	Landfill costs reduced from approx. $300k to $0	($18,761,496)	$1,017,292	$35,224,476	$230,344,105	$253,378,516	($114,904,889)	$4,784,659
Change from Baseline ------------>		$313,740	$409,360	($3,397,145)	$0	$0	$3,294,270	$4,180,586
10a. Labor costs lower	Labor costs lowered 10% across the board	($18,421,491)	$1,460,921	$31,567,010	$230,344,105	$253,378,516	($111,374,061)	$9,289,729
Change from Baseline ------------>		$653,745	$852,989	($7,054,612)	$0	$0	$6,825,097	$8,685,656
10b. Labor costs significantly lower	Labor costs lowered 30% across the board	($17,114,001)	$3,166,899	$27,787,494	$230,344,105	$253,378,516	($97,723,866)	$26,661,041
Change from Baseline ------------>		$1,961,235	$2,558,967	($10,834,127)	$0	$0	$20,475,292	$26,056,967
11a. Lower Oil Prices by approx. 20%	Lower truck and rail costs, ethanol sale price and feedstock price	($25,739,436)	($8,087,337)	$27,633,737	$230,344,105	$253,378,516	($187,580,562)	($135,021,367)
Change from Baseline ------------>		($6,664,200)	($8,695,269)	($10,987,885)	$0	$0	($69,381,404)	($135,625,441)
11b. Higher Oil Prices by approx. 20%	Raise truck and rail costs, ethanol sale price and feedstock price	($12,394,836)	$9,324,339	$33,166,299	$230,344,105	$253,378,516	($48,649,032)	$89,234,256
Change from Baseline ------------>		$6,680,400	$8,716,407	($5,455,322)	$0	$0	$69,550,126	$88,630,182
12a. Truck transport cost increase	Increase truck transportation (and feedstock) cost by 7%	($19,507,416)	$44,035	$38,561,622	$230,344,105	$253,378,516	($122,737,049)	($7,857,653)
Change from Baseline ------------>		($432,180)	($563,897)	($60,000)	$0	$0	($4,537,890)	($8,461,727)
12b. Truck transport cost decrease	Increase truck transportation (and feedstock) cost by 7%	($18,643,056)	$1,171,829	$33,942,020	$230,344,105	$253,378,516	($113,661,269)	$6,362,872
Change from Baseline ------------>		$432,180	$563,897	($4,679,602)	$0	$0	$4,537,890	$5,758,799

Scenario	Change Created by Scenario	Year 1 First Full Scale Year Profit	Year 10 Profit	Year 20 Profit	Construction Cost	Total Debt	Ten Year Present Value Profit	Twenty Year Present Value Profit
13a. Rail transport cost increase	Increase rail costs 7% and adjust feedstock sale price accordingly	($19,264,236)	$361,330	$38,988,039	$230,344,105	$253,378,516	($120,167,594)	($2,856,398)
Change from Baseline ------------>		($189,000)	($246,602)	$366,418	$0	$0	($1,968,435)	($3,460,472)
13b. Rail transport cost decrease	Decrease rail costs 7% and adjust feedstock sale price accordingly	($18,886,236)	$854,534	$36,585,008	$230,344,105	$253,378,516	($116,230,724)	$3,112,057
Change from Baseline ------------>		$189,000	$246,602	($2,036,614)	$0	$0	$1,968,435	$2,507,983
14a. Federal tax incentives reduce rate to 25%	Reduce federal tax rate to 25%	($19,075,236)	$607,932	$38,821,002	$230,344,105	$253,378,516	($118,199,159)	$717,778
Change from Baseline ------------>		$0	$0	$199,380	$0	$0	$0	$113,704
14b. State and Fed rates reduce effective Fed tax to 0%	Reduce federal tax rate to 0%	($19,075,236)	$607,932	$39,319,452	$230,344,105	$253,378,516	($118,199,159)	$1,002,037
Change from Baseline ------------>		$0	$0	$697,830	$0	$0	$0	$397,963
15a. State taxes all reduced to zero	Reduce all state taxes to zero	($19,075,236)	$619,675	$38,637,403	$230,344,105	$253,378,516	($118,154,159)	$739,074
Change from Baseline ------------>		$0	$11,743	$15,782	$0	$0	$45,000	$135,000
15b. Proprety taxes due all years at $9000	Include property taxes for all years at $9000	($19,084,236)	$607,932	$38,621,622	$230,344,105	$253,378,516	($118,262,159)	$541,074
Change from Baseline ------------>		($9,000)	$0	$0	$0	$0	($63,000)	($63,000)
15c. Full State Property and Income Taxes	Include property taxes at $12,000 and state tax at 5%	($20,907,407)	($685,927)	$39,314,191	$240,988,375	$265,087,213	($132,936,847)	($18,458,125)
Change from Baseline ------------>		($1,832,170)	($1,293,859)	$692,570	$10,644,270	$11,708,697	($14,737,688)	($19,062,199)
16a. State Producer Credit - 15 cents per gallon	15 cent per gallon producer credit through year 5, phase out to year 8	($10,075,236)	$607,932	$25,552,120	$230,344,105	$253,378,516	($60,464,159)	$38,131,824
Change from Baseline ------------>		$9,000,000	$0	($13,069,501)	$0	$0	$57,735,000	$37,527,750
17a. Higher product demand	Increase ethanol sale price by 15%	($8,725,236)	$14,112,335	$37,348,832	$230,344,105	$253,378,516	($10,403,909)	$137,945,986
Change from Baseline ------------>		$10,350,000	$13,504,402	($1,272,789)	$0	$0	$107,795,250	$137,341,913
17b. Higher product supply	Reduce ethanol sale price by 15%	($29,425,236)	($12,896,470)	$21,170,664	$230,344,105	$253,378,516	($225,994,409)	($210,293,213)
Change from Baseline ------------>		($10,350,000)	($13,504,402)	($17,450,957)	$0	$0	($107,795,250)	($210,897,287)
18a. No market for carbon dioxide	Reduce carbon dioxide sale price to $0	($19,944,006)	($525,615)	$37,796,058	$230,344,105	$253,378,516	($127,247,398)	($16,733,903)
Change from Baseline ------------>		($868,770)	($1,133,548)	($825,563)	$0	$0	($9,048,240)	($17,337,977)
18b. Higher market for carbon dioxide	Increase carbon dioxide sale price from $7 per ton to $9 per ton	($18,827,016)	$931,803	$35,946,869	$230,344,105	$253,378,516	($115,613,947)	$3,897,891
Change from Baseline ------------>		$248,220	$323,871	($2,674,752)	$0	$0	$2,585,211	$3,293,817
18c. Much higher market for carbon dioxide	Increase carbon dioxide sale price from $7 per ton to $11 per ton	($18,578,796)	$1,255,674	$33,272,117	$230,344,105	$253,378,516	($113,028,736)	$7,191,709
Change from Baseline ------------>		$496,440	$647,742	($5,349,505)	$0	$0	$5,170,423	$6,587,635
19a. Higher electric costs	Increase sale price of electricity by plant by 35%	($17,744,534)	$2,344,198	$27,068,827	$230,344,105	$253,378,516	($104,339,889)	$18,262,167
Change from Baseline ------------>		$1,330,703	$1,736,265	($11,552,794)	$0	$0	$13,859,270	$17,658,093
19b. Lower electric costs	Decrease sale price of electricity by plant by 35%	($20,405,939)	($1,128,333)	$36,986,056	$230,344,105	$253,378,516	($132,058,428)	($26,164,261)
Change from Baseline ------------>		($1,330,703)	($1,736,265)	($1,635,565)	$0	$0	($13,859,270)	($26,768,335)

unlikely, but, with an unproven technology, they may cause a late start or unforeseen shut downs within the first two months. This would cause a loss of revenue within the first two months (assuming 50% downtime) that could add $3.4 million to the current cost of construction.

The effect of this $3.4 million start-up expense would be a $3.0 million total reduction in return on investment. This scenario has a lower impact than the increased on-site costs, because start-up costs are all attributed to the second construction year, rather than rolled into increased loan costs.

<u>5.2.3 Environmental Permitting</u>

Some New York sites require complicated environmental permitting. This has not been reviewed for the Sackets Harbor site. Therefore, cost of environmental permitting and regulation could add $250,000 to project construction and start-up costs.

The effect of this additional permitting cost rolled into the construction loan be a $295,000 reduction in return on investment over 20 years.

<u>5.2.4 Variation of Interest Rates</u>

Interest rates for this program are based on a few assumptions. They are based on the assumption that the initial investments for capital expenses would be obtained under standard loans from banks and/or investors, and that they would expect a fixed rate over a ten-year period from the plant. The current case is based on Raytheon's estimate of an 11% interest rate. There are a few situations that could result in lower interest rates. If the loans were to be guaranteed by the State or federal government, they could be provided by a bank at a level closer to 8%. A loan with a significant government subsidy or support could be provided for as low as the rate of inflation (assumed to be 3% for this study).

While loan programs may move the risk of plant problems from the investor to the government, the result is that plant profitability for this baseline case becomes immediately more feasible. This is because loan guarantees have a significant effect on the profitability of the facility. With an interest rate set at 8%, the facility shows a return on investment of $51.6 million. The facility shows a profit in year 8. With a 3% interest rate the facility shows a profit in Year 1, and pays off all construction year expenses and starts providing a return to investors by year 5. Total return on investment is $128.7 million.

<u>5.2.5 Debt-Equity Ratios</u>

Investor-owned plants could use investor dollars for funding the program. The current pro-forma assumes no base equity from the participant investors. The establishment of a 9:1 or a 2.33:1 debt-to-equity ratio was reviewed. The first case would require 10% up-front financing, totaling $23.0 million, while the second case would require 30% up-front financing, totaling $69.1 million. Unless a major corporation were to take an interest in the ethanol plant, it is unlikely that funds in these ranges could be secured.

In the first case, the plant will see a total twenty-year return on investment of $14.6 million; while in the second case, the plant will see a total twenty-year return on investment of $42.6 million. Despite bringing in larger profits, these numbers are unlikely to cause a participant to invest up-front equity that exceeds the full twenty-year return on investment.

5.2.6 Depreciation Levels

A well-designed ethanol plant will last for a number of years beyond the initial depreciation timeframe for the capital equipment. This allows the plant to make significant profits after the completion of depreciation, or to put funds into the upkeep and expansion of the plant beyond the depreciation years. Nonetheless, investors are mainly concerned with the return in the first five, ten, or twenty years, when full depreciation is being attributed to the plant. GAAP suggests depreciation based upon a straight-line rate over the life of the plant, usually over twenty years. Variations of depreciation curves for longer or shorter plant lifetimes will be assessed, including ten, fifteen, and twenty-five years. Unfortunately, it is unlikely that investors would allow deviation from the twenty-year straight-line depreciation system.

Shorter depreciation timeframes make the plant less profitable by the tenth or twentieth year. With a ten-year depreciation curve, the plant loses an additional $99.2 million from the baseline when reviewed based upon ten-year return on investment. By year 20, that difference is not yet overcome, as the twenty-year return on investment is still $27.1 million lower than the baseline. A five-year depreciation creates an even worse financial picture, with a twenty-year return on investment that is $42.4 million below the baseline. When depreciation is extended to twenty-five years, there is an improvement in return-on-investment, resulting in a savings of $21.0 million over the first twenty years.

5.2.7 Feedstock Costs

Annual cost of biomass feedstock is assumed to be $35 per ton, based on the cost of collecting and transporting corn stover while providing some profit to farmers who participate. NYSTEC also assessed the effects on this baseline pro-forma that occurred when feedstocks were available at different costs. Costs that were reviewed include the cost of biomass in a more competitive market ($50 per ton), the cost of dedicated energy-farm feedstock supplies in the long term ($75 per ton), the current cost of hay ($100 per ton), the rates for a similarly designed plant that could use a 50/50% mix of corn stover and corn (at $59 per ton), and the use of a 50/50% biomass and paper mill waste mix (at $18 per ton).

Feedstock costs have a significant effect on the profitability, return on investment, and feasibility of the entire biomass-to-ethanol processing industry. At the baseline cost of $35 per ton, the plant shows a twenty-year return on investment of $0.6 million. At other biomass costs, the returns are as follows:

- At $50 per ton, the return over 20 years is a negative $257.3 million
- At $59 per ton, the return over 20 years is a negative $412.3 million
- At $75 per ton, the return over 20 years is a negative $687.8 million
- At $100 per ton, the return over 20 years is a negative $1,118.3 million
- At $18 per ton, the return over 20 years is $190.9 million

Therefore, it is clear that the cost per ton of biomass is a major deciding factor in the ability to secure future profitability of a biomass-to-ethanol processing facility. Although the current facility would still not secure investors in the base case with biomass guaranteed at $18 per ton, there is a future potential for the return on investment at this low biomass cost to be feasible.

But, at the current cost of New York hay ($100 per ton), over a billion dollars in losses would need to be overcome in order to create a profitable biomass processing plant. This is unlikely to ever occur. At this time, farmers are providing a variety of responses on the potential purchase price for corn stover and other biomass feedstocks. Although we are comfortable that the baseline price of $35 is realistic, more detailed analysis of the potential cost for biomass feedstocks would be necessary before any investor would be willing to make the commitment to a processing facility.

5.2.8 Cost of Enzymes

Raytheon Engineering and Constructors developed construction-cost estimates and some operating-cost estimates based upon two scenarios. One scenario provides for in-house cellulase enzyme production, while the other scenario provides for enzyme purchase from a vendor. Raytheon Engineering and Constructors recommended in-house production despite the larger up-front capital cost. For this step in the sensitivity analysis, NYSTEC reviewed the case with off-site enzyme production.

This case saves $18.1 million in up-front construction costs and $19.9 million in total debt, including construction cost and working capital. There are additional savings in labor costs. But, NYSTEC's best estimate suggests that the twenty-year return on investment would be more than $500 million lower if enzymes were being purchased from off-site at a rate that Raytheon Engineering and Constructors set at $150 per pound. Because cellulase costs are only estimates provided by Raytheon Engineering and Constructors, and cellulase quantities are only estimates provided by NYSTEC, we cannot be completely confident that this would be the exact magnitude of lost return. But, it is clear that the additional construction cost for cellulase production creates more certainty as well as more profit in the baseline pro-forma.

5.2.9 Land-spread Wastes

The current pro-forma estimates that wastes will be landfilled at a cost of over $300,000 per year. Raytheon Engineering and Constructors has indicated that, with proper permits, these wastes might be land spread at no cost. The effect on profit of this option was assessed.

This scenario results in an additional twenty-year return on investment of $4.2 million.

5.2.10 Cost of Labor

Raytheon Engineering and Constructors indicated that it estimated labor rates based on similar operations elsewhere. Based upon the rates for similar industrial operations in the North Country area, there was some feeling that the baseline estimates provided by Raytheon Engineering and Constructors might be high. Those estimates are approximately 58% higher than the labor rates that NYSTEC has used in a similar corn-to-ethanol study. The effects of a 10% and a 30% reduction in labor costs were assessed. The first case brought average production salaries down to $45,093, and average administrative salaries down to $58,500. The second case brought average production salaries down to $35,072, and average administrative salaries down to $45,500.

The result of these two cases shows the linear relationship between labor rates and return-on-investment over twenty years. Each one-percent reduction in labor rates results in a twenty-year increase in return of $869,000. A ten-percent reduction creates an additional $8.7 million, while a thirty-percent reduction results in a $26.1 million additional return.

5.2.11 Oil Prices

Variations in oil prices will effect the price of ethanol, the cost of feedstocks, and the cost of transportation for feedstocks and finished products. It would also have the effect of adjusting the sale price of ethanol to account for its reliance on the price of gasoline. The effects of a 20% increase and a 20% decrease in oil costs were assessed, along with the effects that these changes would have on the cost of ethanol, feedstock, and transportation.

A 20% increase in oil costs would raise the pre-tax profits in a given year by $6.6 million (in 1999 dollars), while a 20% decrease in oil costs would reduce the pre-tax profits by a similar amount. The net positive impact of oil cost increases would overcome any negative impacts in transportation and feedstock costs. Over the course of twenty years, a twenty-percent oil cost increase could result in an additional $88.6 million in return-on-investment. But, short of some significant policy change or political upheaval, it is unlikely that oil costs would rise 20% and stay there over the 20-year pro-forma period. A more likely scenario would have oil costs fluctuating within a range that is close to or just above current costs. But, plant investors should be aware that a $6.6 million yearly impact could result in from a twenty-percent cost change.

5.2.12 Cost of Truck Transportation

The effect of a 7% change in truck transport cost was assessed: it would raise or lower feedstock costs by 51 cents per ton.

As would be expected, the effect of this is similar to the effect of having higher or lower feedstock prices in general. In the first year, it impacts profitability by $432,000. Over twenty years, the increased truck costs would reduce return on investment by $8.5 million while the decreased truck costs would improve return on investment by $5.6 million. Because it is likely that trucking costs will fluctuate from year to year, it is unlikely that the entire transportation cost impact would be reflected for the full twenty-year pro-forma time frame. Instead, investors need to be aware that a 7% trucking rate change would create a yearly adjustment in pre-tax profit of $432,000 (in 1999 dollars).

5.2.13 Cost of Rail Transportation

The effect of a 7% change in rail transport cost was assessed. NYSTEC thought this assessment was necessary because of the potential impact on prices that could occur with rail mergers. It is also likely that, if the biomass plant contracts directly with CSX, rather than with a local short-line railroad, prices may be higher than estimated. The cost of transporting ethanol does not directly effect the pro-forma and the plant economics. But, it is assumed that the refiner or blender will be unwilling to pay the same price for ethanol if rail costs are higher. It is also assumed that the refiner or blender would be willing to pay more for ethanol at the plant gate if the cost to transport that ethanol were lower. A 7% rate change has a 0.315 cent per gallon effect on the price of ethanol.

The result of this rail-cost adjustment is smaller than that of a similar change in the cost of truck transportation. In the first year, it impacts profitability by $189,000. Over twenty years, the increased rail costs would reduce return on investment by $3.5 million, while the decreased rail costs would improve return on investment by $2.5 million. Because it is likely that rail costs will fluctuate from year to year (although there is a general trend toward rate reduction in the long term), it is unlikely that the entire transportation cost impact would be reflected for the full twenty-year pro-forma time frame. Instead, investors need to be aware that a 7% rail rate change could create a yearly adjustment in pre-tax profit of $189,000 (in 1999 dollars).

5.2.14 Federal Tax Rates

The baseline assumes a federal tax rate of 35%. This is formed on the basis of an assumption that the facility will be set up as a limited partnership. Therefore, no taxes are charged directly to the partnership, but corporate income taxes at a corporate rate would be due to the partners after the operation starts turning a profit and pays off all losses. Net income may be different if federal taxes are incurred at lower rates. Therefore, the effects of different corporate structures and incentives with tax rates at 25% and 0% were assessed.

The effect of this change on the baseline pro-forma is minimal. It is expected that if the operation were to offset losses earlier, a reduction in federal tax rates would have an impact. But, in the base case, the plant is writing off losses through year 19. Therefore, no federal tax is due, regardless of the rate. If the rate is changed to 25%, a benefit of $199,380 accrues in year 20 ($113,704 in 1999 dollars). At a 0% federal tax rate, the benefit in year 20 is $697,830 ($397,963 in 1999 dollars).

5.2.15 State Tax Rates

The base case assumption is that a State and local set of basic tax incentives are in place. This includes a full property tax exemption for the first five years and a partial (25%) property tax exemption for the remainder of the plant lifetime. State income taxes are set at zero. Also, no sales tax is due on construction equipment. The effect of a full waiver of property taxes and income taxes at the State level was reviewed. A case where the 25% property tax exemption applies for all years, including the first five years, was reviewed. Also, a case where no tax incentives are applied was reviewed.

The full waiver of taxes has a minimal effect on the baseline. This would only further reduce the property taxes from $9000 per year after year 5 to zero. Therefore, the effect on twenty-year return on investment is $135,000. If the tax waiver for the first five years is not included, this also has a minimal effect on return on investment, resulting in a loss of $63,000 in 1999 dollars through the first twenty years. The removal of all incentives has a much larger effect. A full property tax payment (no 25% discount), and application of the 5% income tax to the production facility would result in a loss of $185,852 by year 20. This number would be significantly larger if the operation were to offset losses before year 20. The much larger concern is the application of a 7% sales tax on construction equipment. This would have the effect of adding $10.6 million to construction costs, and would result in an additional loss in the twenty-year return on investment of $18.9 million in 1999 dollars — for a total additional loss of $19.1 million over the baseline case.

5.2.16 Other State Government Incentives

The application of a State government producer credit was also assessed. This is often proposed as one of a number of incentives that could be provided by the New York State government to assist the ethanol industry in New York. For this case, a credit was designed that started at fifteen cents per gallon at the start of production. The credit is phased out between years 6 and 8.

The result of this credit is a twenty-year return on investment of $38.1 million. Although this would not be enough to justify the $253 million construction loan required, it is a significant assistance to the profitability of the plant. Additionally, it is valuable because it assists the plant in the early years, when cash flow problems tend to exist. Although this credit would not assist a biomass-to-ethanol plant if built today, it does have an effect that would be helpful to developing the corn-to-ethanol industry, and could also assist the biomass-to-ethanol industry in the future. States that have instituted this credit are the states with corn-to-ethanol projects in the construction phase at this time. Therefore, this should be reviewed in more detail by the biomass-to-ethanol investors as more economically feasible baseline plant designs are developed in future years.

5.2.17 Product Sale Price

The effects of a 15% higher ethanol product price due to increased demand and of a 15% lower product price due to lower-than-expected demand were assessed.

Much like feedstock costs, ethanol prices have a significant effect on the profitability of the production plant. Because these prices tend to vary with the price of oil and gasoline, they could potentially cause advantages or disadvantages to investors that would be unknown at the time of construction. A 15% adjustment in ethanol prices has the effect of adding (or subtracting) $10.4 million in 1999 dollars from the return on investment in any given year. If ethanol prices over twenty years stayed, on average, 15% higher than the baseline price of $1.15 per gallon, an additional return on investment of $137.3 million would result. If prices stayed 15% lower, the return on investment over twenty years would be $210.9 million less than the base case.

5.2.18 Market for Carbon Dioxide

The effect on profit was assessed for different CO_2 markets. If there is no market for CO_2 near the plant, CO_2 is not sold and no profit would be realized for this co-product. The effect of this condition was assessed. Based upon evidence of a lack of CO_2 availability for upstate New York producers, it is likely that this product is in high demand. If so, prices higher than our initial prediction ($7 per ton) are also possible, including $9 and/or $11 per ton. Effects of these higher prices were assessed.

A lack of a market for CO_2 would have a reasonable effect on plant profits, resulting in a loss of $869,000 per year (in 1999 dollars). This would reduce the twenty-year return on investment by $17.3 million. If a market was stronger than predicted, an additional $2 per ton would result in an additional $248,000 in each year (in 1999 dollars) and a total return that is $3.3 million higher than predicted. An additional $4 per ton would result in an additional $496,440 in each year (in 1999 dollars), and a total return that is $6.6 million higher than predicted.

5.2.19 Electricity Industry Issues

The electricity industry in New York is currently undergoing a complicated deregulation process, making electric costs very difficult to assess. The baseline prices that would be paid for electricity sold to the grid were provided by Niagara Mohawk Power Corporation. However, these prices may be higher, if they stay in the range of standard prices that Niagara Mohawk charges to customers that purchase electricity from Niagara Mohawk. On the other hand, continued competition could also drive prices even lower. Therefore, the effects of higher or lower (by 35%) electric costs were assessed.

A 35% increase or decrease in the price that the plant receives for electricity would have an effect of a corresponding increase or decrease of $1.3 million (in 1999 dollars) for each year that prices are effected. Because the plant is selling electricity as a co-product, the higher electrical prices will result in a better return on investment. Over the course of the twenty-year pro-forma period, the total return on investment would be $17.7 million higher if electricity prices were up 35%, and $26.8 million lower if electricity prices were down 35%. Most likely, electricity prices will begin at a rate higher than predicted, and decrease as the deregulated industry invites more competition. Therefore, investors should be aware that the quoted price is probably a reasonable twenty-year average, but that dependence upon this return in the later years is not advisable.

5.3 Conclusions From Sensitivity Analysis

The sensitivity analysis phase of the biomass-to-ethanol project outlines some of the issues and their effects on the magnitude of profitability that the plant could realize. Some advantages, like guarantees that lower interest rates or State producer credits, could have a significant impact on the profitability of the plant. Meanwhile, certain risk factors, like higher biomass costs or lower ethanol sale prices, could have a severe negative impact on even the most profitable production technology.

5.4 Job Creation Analysis

Finally, NYSTEC conducted a preliminary review of the effect on jobs and economic development that would be realized from a biomass-to-ethanol processing facility. These numbers are preliminary estimates, but they provide an idea of the potential that could be realized from a large processing facility at or near Sackets Harbor.

The result of this review is provided in Table 7 (on the following page), Tax Impacts, Incentive Impacts, and Job Creation Estimates. The initial pro-forma page on tax impacts outlined the effect of State taxes from plant jobs and their induced multiplier effects. Based upon information provided by the NY Corn Growers Association for the corn-to-ethanol industry, NYSTEC provided a preliminary assessment of on-farm and off-farm jobs created by this industry and the effect that this would have on State revenue. The extended form (Table 7) shows the effect of 500 additional indirect jobs from the farms and the trucking industry as well as their induced multiplier effects.

Table 7, Tax Impacts, Incentive Impacts, and Job Creation Estimates

	Const. Yr 1	Const. Yr 2	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9
Taxable Income	(236,487)	(25,219,724)	(19,075,236)	(17,079,777)	(15,081,351)	(13,075,299)	(9,827,097)	(7,826,681)	(5,802,135)	(3,747,763)	(1,657,538)
Cumulative taxable	(236,487)	(25,456,211)	(44,531,448)	(61,611,225)	(76,692,576)	(89,767,875)	(99,594,971)	(107,421,652)	(113,223,787)	(116,971,550)	(118,629,088)
Federal Taxes	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
State Taxes	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Sales Taxes	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Property Taxes	$12,000	$12,000	$12,000	$12,000	$12,000	$12,000	$12,000	$12,000	$12,000	$12,000	$12,000
Incentives	$12,000	$12,000	$12,000	$12,000	$12,000	$12,000	$12,000	$3,000	$3,000	$3,000	$3,000
Total Tax Burden	$0	$0	$0	$0	$0	$0	$0	$9,000	$9,000	$9,000	$9,000
Jobs Created	0	46	104	104	104	104	104	104	104	104	104
Mulitplier Jobs	0	55	125	125	125	125	125	125	125	125	125
Construction Jobs	200	200	20	0	0	0	0	0	0	0	0
On Farm Jobs	0	140	300	300	300	300	300	300	300	300	300
Trucking Jobs	0	80	200	200	200	200	200	200	200	200	200
Multiplier from Farm and Trucking Jobs	0	264	600	600	600	600	600	600	600	600	600
State/Local Job Impact	$0	$3,440	$7,819	$7,819	$7,819	$7,819	$7,819	$7,819	$7,819	$7,819	$7,819
Total Impact Value	$0	$2,699,617	$10,546,513	$10,390,129	$10,390,129	$10,390,129	$10,390,129	$10,399,129	$10,399,129	$10,399,129	$10,399,129
Cost of $0.15 prod. credit	$0	$3,735,000	$9,000,000	$9,000,000	$9,000,000	$9,000,000	$9,000,000	$6,000,000	$3,000,000	$0	$0
Total Remaining Gov't Revenue	$0	($1,035,383)	$1,546,513	$1,390,129	$1,390,129	$1,390,129	$1,390,129	$4,399,129	$7,399,129	$10,399,129	$10,399,129

*** All values in current year dollars**

	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
Taxable Income	474,930	2,656,418	4,894,131	7,195,733	9,730,425	12,180,147	14,720,053	14,944,682	15,162,769	15,374,504	22,432,334
Cumulative taxable	(118,154,159)	(115,497,741)	(110,603,610)	(103,407,876)	(93,677,452)	(81,497,305)	(66,777,253)	(51,832,570)	(36,669,801)	(21,295,297)	1,137,037
Federal Taxes	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$397,963
State Taxes	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Sales Taxes	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Property Taxes	$12,000	$12,000	$12,000	$12,000	$12,000	$12,000	$12,000	$12,000	$12,000	$12,000	$12,000
Incentives	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000	$3,000
Total Tax Burden	$9,000	$9,000	$9,000	$9,000	$9,000	$9,000	$9,000	$9,000	$9,000	$9,000	$406,963
Jobs Created	104	104	104	104	104	104	104	104	104	104	104
Mulitplier Jobs	125	125	125	125	125	125	125	125	125	125	125
Construction Jobs	0	0	0	0	0	0	0	0	0	0	0
On Farm Jobs	300	300	300	300	300	300	300	300	300	300	300
Trucking Jobs	200	200	200	200	200	200	200	200	200	200	200
Multiplier from Farm and Trucking Jobs	600	600	600	600	600	600	600	600	600	600	600
State/Local Job Impact	$7,819	$7,819	$7,819	$7,819	$7,819	$7,819	$7,819	$7,819	$7,819	$7,819	$7,819
Total Impact Value	$10,399,129	$10,399,129	$10,399,129	$10,399,129	$10,399,129	$10,399,129	$10,399,129	$10,399,129	$10,399,129	$10,399,129	$10,797,092
Cost of $0.15 prod. credit	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Remaining Gov't Revenue	$10,399,129	$10,399,129	$10,399,129	$10,399,129	$10,399,129	$10,399,129	$10,399,129	$10,399,129	$10,399,129	$10,399,129	$10,797,092

The on-farm jobs are estimated based upon the job-creation data from the corn-to-ethanol industry. It is assumed that biomass processing will create fewer farm jobs than corn processing, because farm work will be limited to collecting and preparing stover and other wastes. Trucking jobs will be a significant factor for a biomass-to-ethanol processing facility that produces 60 million gallons of ethanol per year.

In an average year, all the jobs could bring the State and local governments $10.4 million in tax dollars. Even with a producer credit, the State and local governments would still see a benefit to the tax rolls in all but one year. After the credit is removed, a full $10.4 million benefit is realized for years beyond year 8.

NYSTEC would like to provide New York State with the most accurate assessment of the positive economic-development impacts, in addition to the positive environmental impacts, created by both on-farm and off-farm jobs for both corn-to-ethanol and biomass-to-ethanol processing. These activities will require additional work in the future.

6. CONCLUSIONS

Throughout the past year, NYSTEC has been evaluating the feasibility of ethanol production in New York State. A number of opportunities may exist to locate ethanol-processing plants in upstate New York and to take advantage of the available feedstocks and the support from the local crop-growing community.

Over the past few years, several organizations in New York State have been pursuing biomass energy as an alternative source for electric-power generation. The significant availability of hay and grasses, the significant waste product tonnage from the forest industry, the availability of urban wood waste, and the availability of former farmland for use as energy farms have all made New York a viable case for a biomass-to-electricity industry.

As the biomass-to-electricity research has shown, there is a significant quantity of available biomass feedstocks and feedstock capacity in upstate New York. Even without dedicated crops for energy generation, there is a supply of waste feedstocks such as corn stover that is adequate to supply a biomass-to-ethanol processing plant. With the addition of hay and straw, existing feedstocks could support multiple plant locations in upstate New York. NYSTEC is actively exploring a corn-to-ethanol processing industry for upstate New York. But, with a biomass resource that is larger and more underutilized than the corn resource, biomass-to-ethanol processing has the potential to open up the ethanol industry to New York State even if corn processing is not pursued.

In and around its study location at Sackets Harbor, NYSTEC reviewed several other locations with potential to be developed for ethanol processing facilities. Although the Sackets Harbor site was reviewed specifically for this project, it appears that site drawbacks may outweigh any advantages that could be found from locating near the existing grain processing operation of Robbins Corn and Bulk Service. Nonetheless, several suitable sites, including a number of former processing facilities, are available in the region within fifty miles of adequate feedstock supplies.

The biomass-to-ethanol technology is expensive and, therefore, works best if done on a large scale. This overwhelming plant size is a major barrier to feasibility of this project today. Construction costs are estimated to exceed $230 million. Even if the plant were to be significantly profitable, it is unlikely that upstate New York industries could finance this operation on their own. With active support of government agencies, other organizations could be willing and able to provide financing — or at least the necessary up-front equity to overcome such a cost. But it is more likely that biomass processing will become feasible when it can be accomplished for a lower construction cost or it can be operated in plants with capacities smaller than 60 million gallons per year.

Even if construction cost issues were overcome, a major barrier remains with the profitability of the operation in its current form. In the baseline pro-forma, profits are minimal, and the plant sees no cumulative return on the construction investment for the first nineteen years. In first full year of production, the ethanol plant sees a total loss of $19.1 million. The plant starts reporting yearly income beginning in Year 10, and sees a significant jump in income with the completion of the depreciation schedule in Year 20. By Year 20, the plant has an annual income of $38.6 million. Although a small profit is shown over the 20 years, it does not justify the large up-front capital investment. The plant provides a return-on-investment after 20 years that is barely 0.3% over the annual effects of inflation. Therefore, this baseline scenario will be unable to secure investments for construction.

The sensitivity analysis phase highlights a number of issues and opportunities that exist with the current and future biomass-to-ethanol processing technology. With some positive developments in place before the plant is in operation, there could be a significant positive impact on the profitability of the plant. Meanwhile, certain risk factors — like higher biomass costs or lower ethanol sale prices — could have a severe negative impact on even the most profitable production technology.

Feedstock costs also have a significant effect on profitability, return on investment, and feasibility of the biomass-to-ethanol processing industry. At the baseline cost of $35 per ton, the plant shows a twenty-year return on investment of $0.6 million. At $50 per ton, the return over 20 years is a negative $257.3 million. At $100 per ton, the return over 20 years is a negative $1,118.3 million. At $18 per ton, the return over 20 years is $190.9 million.

Ethanol prices have a significant effect on the profitability of the production plant. Because these prices tend to vary with the price of oil and gasoline (but not necessarily with the price of feedstocks), they could potentially cause advantages or disadvantages to investors. A 15% adjustment in ethanol prices has the effect of adding or subtracting $10.4 million (in 1999 dollars) to/from the return on investment in any given year.

With support from the government, the biomass-to-ethanol industry may move closer to reality. Two candidate government programs that were reviewed in the sensitivity analysis phase of this project have a significant effect on profitability. One such program entailed a loan guarantee that would bring down interest rates. While the baseline interest rate was set at 11%, a guarantee that brought rates down to 8% would show a return on investment of $51.6 million. The facility would show a profit in year 8. With a 3% interest rate the facility would show a profit in Year 1, and a total return on investment of $128.7 million. Another valuable government program would provide a production credit for ethanol producers. Some states have pursued such a policy to have corn-to-ethanol processors build in their state. The result of this seven-year credit is a twenty-year return on investment of $38.1 million. This is valuable because it assists the plant in the early years when cash flow problems tend to exist. Although this credit would not be large enough to make a biomass-to-ethanol plant financially feasible if built today, it does have an effect that would be helpful to developing the corn-to-ethanol industry, and also could assist the biomass-to-ethanol industry in the future.

NYSTEC also conducted a preliminary review of the jobs creation and economic development that would be realized from a biomass-to-ethanol processing facility. In an average year, all the jobs created by a 60-million-gallon-per-year plant could bring the State and local governments in New York $10.4 million in tax dollars. Even with a producer credit, the State and local governments would still see a benefit to the tax rolls in all but one year. After the credit is removed, the full $10.4 million benefit is realized for years beyond year 8. This type of data should be helpful in convincing State and local governments of the significant benefits that could be accrued in the operation of a local biomass-to-ethanol production facility.

7. RECOMMENDATIONS FOR FURTHER WORK

NYSTEC's Alternative Fuel Technology Center (AFTC) has learned a great deal about ethanol production while conducting this NREL-sponsored study. Its evaluation of New York State feedstock options, including a number of biomass alternatives, has provided a good foundation for insight into the cost drivers in the production process. This insight will help NYSTEC identify cost-effective solutions. In addition to examining the applicability (technical and cost) of NREL's lignocellulosic biomass technology to the New York State environment, NYSTEC also examined the current state of the art in corn-to-ethanol technology.

Results of NYSTEC's studies indicate that the lignocellulosic biomass technology for fuel ethanol production is not yet economically feasible for the New York State environment. However, the potentially significant positive aspects of this technology mark it as an excellent candidate for future application in New York State. Therefore, NYSTEC will continue to monitor the development and evolution of lignocellulosic biomass technology to assess the potential for a future successful implementation in New York State.

NYSTEC's findings resulting from the NREL study, coupled with its examination of the current state of the art in corn-to-ethanol technology, have revealed potential economics in New York State ethanol production that it feels warrant further investigation. In particular, NYSTEC recommends:

- Further work to ascertain the complete financial and market picture through the development of a business plan for New York State ethanol production implementation, and
- Evaluation of the economic viability of building a current state-of-the-art ethanol plant and scarring it to allow for future conversion to lignocellulosic biomass-based ethanol production.

The business plan development will logically continue NYSTEC's ethanol-feasibility work to the next step (given the favorable results seen in this project) and is expected to form the basis for New York State ethanol production moving from feasibility to reality in the future.